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SPECIFICATION

(54) Title of the Invention: DISPLAY DEVICE

(57) Claims

1. A display device having a structure in which a container is formed by an upper substrate and a lower substrate opposing each other through a spacer and sealed at the peripheries thereof with sealant; the upper and lower substrates respectively have upper and lower electrodes formed on the inner surfaces thereof; terminals of the upper electrodes formed on the inner surface of the upper substrate and pads formed on the inner surface of the lower substrate are electrically connected to each other; and voltage-supplying terminals of the upper electrodes are arranged so as to be flush with terminals of the lower

electrodes formed on the lower substrate, comprising: projections not higher than the spacer, disposed at portions corresponding to the pads, of at least one of the upper and lower substrates; and conductive adhesive applied on the upper surfaces of the projections such that the pads and the terminals of the upper electrodes are electrically connected to each other, wherein the electrical connection with the conductive adhesive is performed at the same time of sealing the upper and lower substrates, and the spacer with the sealant.

2. Display device according to Claim 1, wherein the projections comprise frit glass.

Detailed Description of the Invention

The present invention relates to a display device, and more particularly, it relates to an electrical connecting structure of an upper substrate and a lower substrate.

In general, a variety of display devices such as an electric-discharge display device, and a fluorescent display device includes a type in which display electrodes and counter electrodes are disposed on the common surface of an insulating substrate so as to two-dimensionally oppose each other and another type in which display electrodes and counter electrodes are disposed on the opposing surfaces of opposing substrates so as to three-dimensionally oppose each other. Figs. 1a and 1b are respectively a perspective view

and a sectional view of an essential part of an example electric-discharge device pertaining to the latter type. In the figures, a lower substrate 1 composed of an insulating material such as glass, ceramics, or the like has display electrodes 2 (hereinafter, referred to display cathodes) disposed on the upper surface thereof and arranged in a pattern of a Kanji character "day", each formed so as to correspond to each column, extending along the longitudinal direction of the lower substrate 1. And the display cathodes 2 are connected to respective cathode terminals 4 juxtaposed at the longitudinal end of the lower substrate 1 through leads 3.

Also, an upper substrate 5 disposed so as to oppose the lower substrate 1 and composed of a transparent glass sheet has counter electrodes (hereinafter, referred to counter anodes) 6 composed of a transparent conductive film, disposed on the inner surface thereof so as to oppose the display cathodes 2, each lying independently from the others so as to correspond to each column. The counter electrodes 6 includes anode terminals 7 extending along the inner surface of upper substrate 5. At the same time, the lower substrate 1 has bonding pads 8 formed on the upper surface thereof by bonding so as to oppose the anode terminals 7 and to be electrically connected to terminals 9 through leads. Also, the lower substrate 1 and the upper substrate 5 have a

spacer 10 obtained by baking and crystallizing crystalline frit glass, interposed therebetween on the peripheral surfaces thereof so as to be held at a gap of about 0.3 to 1.0 mm, and the spacer 10 has sealant 11 bonded on the upper surface thereof, composed of low-melting frit glass, thereby hermetically sealing their peripheries and thus forming an airtight space 12. With this structure, the airtight space 12 has an electric-discharge medium hermetically filled therein, such as neon needed for electrical-discharge. Also, the anode terminals 7 disposed on the inner surface of the upper substrate 5 and the bonding pads 8 on the lower substrate 1 have conductive adhesive 13 injected in the opposing space therebetween and baked for bonding at the same time of baking the sealant 11 for sealing; thus, the counter anodes 6 on the upper substrate 5, each formed so as to correspond to each column, are electrically connected to the terminals 9 through the anode terminals 7, the adhesive 13, the bonding pads 8, and leads.

In the electric-discharge display device having the above-described structure, when one of the cathodes terminals 4 and one of the terminals 9 are selected and a voltage is applied between them, of display columns connected to the selected terminal 9, only the display cathode 2 connected to the selected terminal 9 discharges electricity and emits light; accordingly, when arbitrary

ones of the cathodes terminals 4 and those of the terminals 9 are selected and voltages are applied therebetween, a symbol in a desired display pattern can be displayed at a desired column by emitting light. Thus, when this operation is performed sequentially in a time-sharing manner at a speed, the extent to which eyes do not feel flickering, patterns different from one another can be displayed at a plurality of columns.

Meanwhile, in the electric-discharge display device having the above-described structure, the conductive adhesive 13 is previously applied at predetermined positions, and connections between the anode terminals 7 of the counter anodes 6 and the bonding pads 8 on the lower substrate 7 are performed across the opposing surfaces thereof at the same time of baking the sealant 11 for sealing on the occasion of forming an airtight container. Hence, the conductive adhesive 13 must be applied so as to be thicker than the spacer 10. In other words, it must be applied in a sufficiently mounded manner on either or both the upper surfaces of the anode terminals 7 of the counter anodes 6 and the bonding pads 8. Accordingly, in a display device having a large number of display columns, although a screen printing method or the like is suitable for commercially and uniformly applying the conductive adhesive 13, it is unsuitable for performing a printing operation so as to be

thicker than the spacer 10 and has a drawback of performing the printing operations more than twice.

Accordingly, it is an object of the present invention to provide a display device in which the above-mentioned drawback of applying conductive adhesive is eliminated.

In order to achieve such an object, a display device according to the present invention has a structure in which projections, each having a height not greater than the thickness of the spacer, are disposed on portions corresponding to the bonding pads, of at least one of the upper and lower substrates; and the conductive adhesive is applied so as to extend from the upper surfaces of the projections to the pads; and electrical connection is performed by baking this adhesive for solidification at the same time of sealing by hermetic sealant.

Figs. 2a, 2b, and 2c are respectively a perspective view and sectional views of an essential part of a display device according to one embodiment of the present invention, and since the same reference numbers as those in Figs. 1a and 1b denote the same elements, their descriptions are omitted. As shown in these figures, cylindrical connecting projections 14, each having a thick wall, are formed by applying frit glass with a printing method or the like on the peripheral surfaces of the bonding pads 8 so as not to be higher than the spacer 10, and conductive adhesive 15

being baked in accordance with the same specification as that of the hermetic sealant 11 is applied so as to connect the apex and the inner wall of each connecting projection 14. As shown in Fig. 2c, when the upper substrate 5 including the counter anodes 6 and the cathode terminals 7 of the counter anodes 6 is superposed on the projections in a state of having the conductive adhesive 15 applied thereon, the upper surfaces of the anode terminals 7 are bonded to the connecting projections 14 in a manner of crushing the paste-like conductive adhesive 15 mounded on the apexes of the projections. When baked together with the hermetic sealant 11 applied on the upper surface of the spacer 10, the conductive adhesive 15 is dried for solidification, and the anode terminals 7 and the connecting pads 8 are connected to each other through the conductive adhesive 15 and are thus electrically connected to the terminals 9.

In the electric-discharge display device having the above-described structure, the cylindrical projections 14 lower than the spacer 10 are formed between the plural anode terminals 7 juxtaposed to one another on the long-side end surface of the upper substrate 5 and the terminals 9 on the lower substrate 1, and the conductive adhesive 15 being baked at the same conditions as the sealant 11 is applied on the apexes and the inner walls of the projections 14 and is then baked together with the hermetic sealant 11, thereby

preventing a problem that the conductive adhesive 15 flows into unnecessary portions and the mutually adjacent terminals are short-circuited. Also, each of the cylindrical projections 14 and the conductive adhesive 15 can be applied by a single printing operation, thereby allowing it to be manufactured with a very simple method and also to be reliably bonded.

Figs. 3a and 3b are respectively a perspective view and a sectional view of an essential part of a display device according to another embodiment of the present invention. Since the same reference numbers as those in Figs. 1a and 1b and Figs. 2a, 2b, and 2c denote the same elements, their descriptions are omitted. These figures differ from Figs. 2a, 2b, 2c in a point that a spacer 16 disposed on the peripheral surface of the lower substrate 1 has projections 16a and 16b protruding in a comb-shape from its long side toward the terminals 9, and a part of each of the projections 16a and 16b is integrally bonded to the corresponding bonding pad 8 so as to cover a part of the same. Meanwhile, the projection 16a is formed in a stepwise shape coming down toward the corresponding bonding bad 8. When the conductive adhesive 15 is applied between the upper surfaces of the projection 16a and 16b of the bonding pads 8 as shown in Fig. 3b and is baked together with the hermetic sealant 11 applied on the upper surface of the spacer 16,

excluding the projections 16a and 16b, after the upper substrate 5 is superposed such that the upper surfaces of the anode terminals 7 of the counter anodes 6 oppose this applied surface, the conductive adhesive 15 is baked for solidification; consequently, the anode terminals 7 are connected to the bonding pads 8 through the conductive adhesive 15 and are thus electrically connected to the terminals 9, thereby achieving the same advantages as described above.

Although the connecting projections are disposed on the lower substrate in the above-described embodiments, the present invention is not limited to such a structure, and even when they are disposed on the upper surface, the same advantages are achieved. In addition, although each of the connecting projections has a cylindrical shape or they are formed in a comb shape from a part of the spacer, the present invention is not limited to the projection having a shape as described, and even when it is formed in one of a variety shapes such as a pillar shape, a conical shape, and a spherical shape, the same advantages are achieved.

As described above, in the display device according to the present invention, since the projections not higher than the spacer are disposed on at least either one of the anode bonding terminals and the bonding pads on the upper or lower substrate; the conductive adhesive is applied so as to

extend from the upper surfaces of the projections to the pads; and electrical connection by the conductive adhesive is performed at the same time of baking the sealant for sealing the upper substrate, the lower substrate, and the spacer, application of the conductive adhesive by printing on the bonding pads twice or more can be eliminated; hence it is merely sufficient that the projections are disposed at predetermined positions on the upper and lower substrates and the adhesive is applied on the surfaces of the projections, thereby achieving stable supply. With this structure, both can be reliably connected, and reliable connection is accordingly achieved. Also, since conductive adhesive is easily supplied, the mass-production feature of the device itself is improved, and in addition, since the conductive adhesive between the anode bonding terminals and the bonding pads is heated with heat in the step for heating the sealant, an additional heating step for solidifying the conductive adhesive is not needed. As a result, various excellent advantages such as drastic improvements in working efficiency and mass production features are offered.

Brief Description of Drawings

Figs. 1a and 1b are respectively a perspective view and a sectional view of an essential part of an example known electric-discharge device; Figs. 2a, 2b, and 2c are respectively a perspective view and sectional views of an

essential part of a display device according to one embodiment of the present invention; and Figs. 3a and 3b are respectively a perspective view and a sectional view of an essential part of a display device according to another embodiment of the present invention.

1: lower substrate, 2: display cathodes, 3: leads, 4: cathode terminals, 5: upper substrate, 6: counter anodes, 7: anode terminals, 8: bonding pads, 9: terminals, 10: spacer, 11: sealant, 12: airtight space, 13: adhesive, 14: projections, 15: conductive adhesive, 16: spacer, 16a, 16b: projections